# SCIENCE

New Series
Vol. LXVIII, No. 1751

Friday, July 20, 1928

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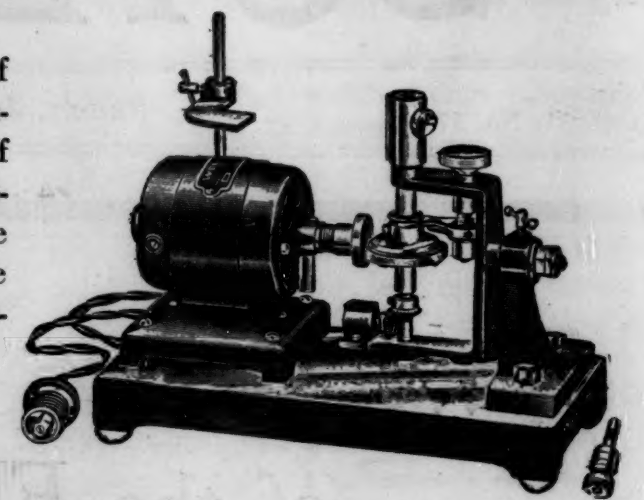

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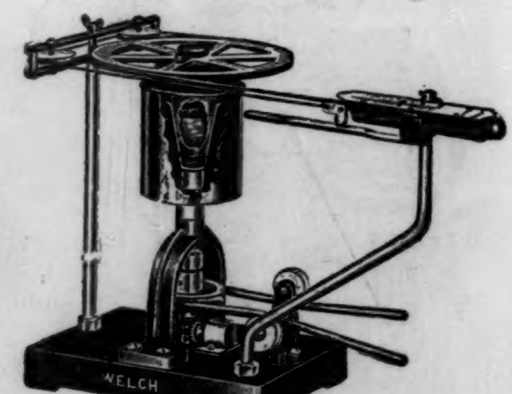


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Vol. LXVIII JULY 20, 1928 No. 1751

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**SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. McKeen Cattell and published every Friday by**

**THE SCIENCE PRESS**

**New York City: Grand Central Terminal.**

**Lancaster, Pa. Garrison, N. Y.**

**Annual Subscription, $6.00. Single Copies, 15 Cts.**

**SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.**

**Entered as second-class matter July 18, 1923, at the Post Office at Lancaster, Pa., under the Act of March 8, 1879.**

## THE CHEMICAL AND PHYSICAL COMPOSITION OF PROTOPLASM[1]

IT is a very great pleasure for me to take part in such a joyful event as the dedication of a new institution devoted to the botanical study and researches. Botany is only a part of biology, and I should like to speak, in my address, on one of the most important problems not only of botany but of biology in general, on the chemical and physical composition of protoplasm.

It is known that life is concentrated in the living contents of cells. The most important part of these contents is protoplasm. It represents the medium in which all other organs of the cell perform their functions. If protoplasm dies no phenomena of life can occur, and the organism becomes a sacrifice of death. It is therefore necessary for all biologists and physicians to know the properties of living protoplasm, its chemical and physical composition. This composition plays a very important part in life and death.

But how can we investigate the chemical composition of protoplasm if at the first touch of our chemical reagents living matter dies? How can we define this composition if we can investigate only the products of destruction of protoplasm?

In order to answer this question we must remember the procedure employed by chemists in their investigations of the chemical composition of new substances. They endeavor first of all to decompose the unknown substance and to determine the chemical composition of products of its destruction. From this chemical composition they arrive at the conclusion concerning the chemical structure of the unknown substance. Then they try to obtain this substance synthetically.

Therefore, in order to determine the chemical composition of living protoplasm, we must first of all investigate the chemical composition of the products of its destruction. Then we must endeavor to form a scheme of the chemical structure of the principal compounds composing living protoplasm. Finally, we must try to obtain these principal compounds artificially.

It is evident that the substances of dead protoplasm we can investigate chemically in our laboratories arise from the substances of living protoplasm. They

[1] Address delivered at the dedication of the new botany building of Wellesley College, Wellesley, Mass., November, 1927.

must be regarded as the products of decomposition of the substances forming living protoplasm. The chemical investigation of dead protoplasm was made only in some cases, namely, it was made on protoplasm of plasmodium of Myxomycetes, on leucocytes and on red blood cells. All kinds of protoplasm proved to contain water, protein substances, fats, sterines and phosphotides; besides, they contained carbohydrates, products of the decomposition of proteins and a small quantity of salts. The dry protoplasm of plasmodium contains, for instance, as principal substances, nucleoproteids (about 50 per cent.) fats, sterines and phosphotides (about 10 per cent.). For the sake of abbreviation we shall call fats, sterines and phosphotides simply "lipoids." The dry protoplasm of leucocytes contains about 80 per cent. nucleoproteids and 16 per cent. lipoids. Finally, the dry protoplasm of red blood cells consists of about 95 per cent. red proteid, haemoglobin, and about 5 per cent. lipoids.

We must, therefore, conclude that the principal component part of protoplasm consists of proteids and lipoids. The protein substances and lipoids can be discovered, by microchemical analysis, also in other cells of plants and animals. At the same time, carbohydrates and products of the decomposition of protein substances represent, evidently, only an admixture because they can be absent, as, for instance, in red blood cells, while salts are always present in a small amount.

It is evident that protein substances and lipoids can represent products which arise from the substances of living protoplasm and form there some compounds which are destroyed by the reagents used in our chemical analysis. But they can be present in living protoplasm in free state. In order to get an idea about the chemical structure of these compounds we can not content ourselves with a chemical analysis and we shall endeavor to apply some physical methods, too.

As is known, living protoplasm possesses the so-called selective permeability. It is very permeable to water and narcotic substances which are soluble in lipoids, as, for instance, alcohol, ether and so on, but it lets salts, sugar and other substances, soluble in water, through with difficulty. The selective permeability of protoplasm disappears after its death. Dead protoplasm lets all substances dissolved in water through very easily. According to the well-known German botanist, Pfeffer, we supposed twenty years ago that the surface of protoplasm is covered by a membrane, by the so-called "plasmamembrane," which only possesses the selective permeability, while the inside of protoplasm is as permeable to all substances as gelatine jelly. According to recently published investigations, Pfeffer's theory proved to be wrong; it was based on an incorrect interpretation of experiments. Protoplasm has no "plasmamembrane," and all its parts possess the selective permeability. We must, therefore, conclude that death is accompanied by changes in protoplasm which bring about the disappearance of the selective permeability of its whole mass. What changes can occur there?

As is known, death can be produced by the agents which alter protein substances chemically, as, for instance, by corrosive sublimate, strong acids, high temperature and strong light. At the same time these agents do not alter lipoids. It is therefore very probable that death is accompanied by some changes in the proteinic part of the compounds forming living protoplasm. On the other hand, it is impossible that protein substances cause its selective permeability; indeed, these substances can not absorb liquid narcotic substances, but they absorb sugar and salts. If living protoplasm had consisted of free protein substances, if it had contained lipoids as an admixture, it would absorb salts and sugar very easily, but it would not let narcotic substances pass through. We arrive therefore at the conclusion that the compounds forming living protoplasm contain not only a protein group, but also substances which absorb narcotics and do not absorb salts and sugar. We can scarcely doubt that these substances are lipoids. Such conclusion is confirmed by the fact that reagents reacting chemically with lipoids (as, for instance, saponin) are poisonous and produce death. On the other hand, all chemical changes of protein substances brought about by different agents annihilate the selective permeability of protoplasm, that is, cause the protoplasm to get rid of its lipoids. Therefore, the lipoids are maintained, in living protoplasm, by proteids; they probably form some chemical compounds with proteids.

Our conclusion is confirmed by the fact that the concentration of narcotics, which is sufficient to bring about the coagulation of protein substances in living protoplasm, is smaller than the concentration of the same narcotic producing the coagulation of protein substances of our laboratories, as for instance, albumen of eggs. Moreover, the greater the solubility of a certain narcotic in lipoids is, the smaller is the concentration of this narcotic which produces the coagulation of proteins of protoplasm in comparison with the concentration of the same narcotic which produces the coagulation of albumen. The close connection between proteids and lipoids in living protoplasm is proved once more by the well-known phenomenon that living protoplasm can not be stained by anilin dyes, while dead protoplasm absorbs these

dyes very easily. Indeed, all protein substances absorb anilin dyes very easily, even if they are dissolved in water; therefore, they can not be in a free state in living protoplasm. Some lipoids, as, for instance, lecithin, absorb anilin dyes, too, and are freed in protoplasm only by death. Finally proteolytic enzymes which dissolve free proteins do not act on living protoplasm at all.

There is, therefore, good reason to believe that the principal substances of living protoplasm represent chemical compounds of proteids and lipoids, but these compounds are so unstable as to be compared with explosive substances; they are destroyed, like the latter, not only by chemical agents and high temperature but also by purely mechanical effects, as, for instance, by a blow. The destruction of these compounds leads immediately to death. But it is quite equitable to ask: Why must the destruction of the compounds of proteids and lipoids in protoplasm bring about death?

In order to answer this question we consider the physical structure of living and dead protoplasm. The living protoplasm has a colloidal structure.

As is known, the colloidal structure, the colloidal state, is the state of a very great dispersion of substances. Substances are dispersed into very minute particles in a mostly liquid medium, which is called the dispersion medium. If we dissolve, for instance, albumen of eggs in water we obtain a colloidal solution in which albumen forms the dispersed phase, water forms the dispersion medium. If we dissolve two or more colloidal substances in water we have two or more dispersed phases in the same solution. The formation of a colloidal solution depends certainly upon the chemical and physical properties of both the dispersion medium and the dispersed phases. If, for instance, water of an albumen solution is replaced by alcohol the colloidal solution can no more exist; and in general if the dispersing medium of a colloidal solution is altered or destroyed the dispersion can not be maintained and the dispersed phases become precipitated. On the other hand, if the dispersed phases themselves are changed chemically, they usually can not remain in the solution and coagulate.

Living protoplasm represents a colloidal solution because it shows all properties of colloidal solutions and, namely, the properties of hydrophilic colloidal solutions. Botanists know very well that the aggregate state of protoplasm of plant cells is liquid. Recently it could be shown that not only plants but also animals possess liquid protoplasm. Its liquid aggregate state is proved by the following well-known facts: living protoplasm which had got rid of the cell walls takes the form of a globe in water; only liquids take this form if they are in another liquid; moreover, in living protoplasm are very often observed movements of particles or the protoplasm flows like a liquid; finally all liquid bodies, as, for instance, water or oil, take in living protoplasm the form of globules.

Although the principal mass of living protoplasm is liquid, it can contain gelatinous granules or fibrils. Moreover, the aggregate state of protoplasm is changeable: the liquid protoplasm can become rigid, partly or in its whole mass. Changes of the aggregate state of protoplasm are often observed on the surface of amoeba and plasmodium. In the axial parts of pseudopodia of foraminifera this change can also be produced by changes of water content of protoplasm. Still oftener strong changes of internal friction of protoplasm are observed. All these changes of the aggregate state and viscosity of protoplasm sometimes proceed very quickly and can be explained only by its colloidal structure. Only hydrophilic colloidal solutions can change their aggregate state and viscosity so rapidly without any change of temperature, as, for instance, it is observed on solutions of gum Arabic or albumen which become gelatinous by evaporation and melt again if they are mixed with water. The often observed disappearance and new appearance of granules in protoplasm are so like the same phenomena in colloidal hydrophilic solutions that one can not now doubt that protoplasm of plants and animals represents a colloidal (hydrophilic) solution.

We have concluded that the principal chemical compounds composing living protoplasm consist of proteids and lipoids. We may now ask: Do these compounds form the dispersion medium or dispersed phases of protoplasm? The above-mentioned behavior of living protoplasm in the solution of anilin dyes and its selective permeability show us that these compounds form the dispersion medium of protoplasm. Indeed, its principal mass remains colorless in relatively strong solutions of anilin dyes, while the most granules absorb them. On the other hand, the osmotic properties of protoplasm are due to the dispersion medium.

It is, therefore, very comprehensible that the destruction of the chemical compounds of proteids and lipoids must produce death. If the dispersion medium of a colloidal system is destroyed the whole system is destroyed, because the colloidal dispersed phases of protoplasm can not remain unchanged too: they must coagulate or dissolve in the surrounding liquid and are therefore lost for life. Death must occur because all phenomena of life depend on the colloidal structure of protoplasm.

The investigation of chemical and physical composition of protoplasm, although it is not yet finished,

permits us therefore to understand such a confused phenomenon as death, but we hope that this investigation will permit us to understand many phenomena of life if we try to obtain the principal substances composing living protoplasm, compounds of proteids and lipoids, artificially.

W. W. Lepeschkin

University of Illinois

## OUR SEARCH FOR CHLOROPHYLL AND FOR THE VITAMINS

### Introduction

During the past decade there is probably no subject that has been given more attention, by scientific groups as well as by the public in general, than that of vitamins. On the other hand, chlorophyll has been given little if any attention even by those who should be studying it most. Vitamins are as ubiquitous in our present-day literature as chlorophyll is in nature. Volumes have been written about both subjects, but still we are in the dark ages regarding the rôle of chlorophyll and the origin of the vitamins. This paper is written to review briefly the struggle of man to know something regarding these two subjects. My purpose is to raise questions in the minds of scientifically-minded men rather than to answer any question regarding chlorophyll or vitamins. The future only can satisfactorily answer these questions.

### A—Chlorophyll

*History of the Chemical Nature of Chlorophyll*

About ninety years ago Berzelius attempted to isolate the green pigment from leaves by the use of strongly reactive reagents and succeeded in obtaining only products of radical decomposition. Thirteen years later Verdeil pointed out a possible relation between chlorophyll and blood. Both pigments were believed to contain iron. The chief result of the earlier period of investigation, in which strong chemical reagents were used, was that chlorophyll was found to be related to hemin.

Nearly fifty years ago the relation between blood and chlorophyll was further strengthened by the work of Hoppe-Seyler. Methods of handling the pigments became more careful, for chemical investigation became more and more dependent upon spectral analytical methods. Willstätter says that the method was far overrated, for it did not prevent serious errors, since many important changes of chlorophyll and its derivatives exert no influence upon the absorption spectrum, while certain insignificant changes of constitution produce disproportionately great changes in the spectrum. Workers of this day found phosphorus and potash present in their preparations of chlorophyll; chlorophyll was considered a lecithin. From the chlorophyllan which was obtained, phylloporphyrin was prepared and this definitely established the blood-chlorophyll relation.

After Hoppe-Seyler, chemical workers made no attempt to isolate or analyze chlorophyll. They believed that its isolation was impossible on account of its alterability, chemical indifference and extreme solubility. Some thirty years ago Schunck and Marchlewski analyzed the acid and alkaline decomposition-products of chlorophyll, but learned nothing regarding its chemical characteristics. The chemists of the day did not seriously consider observations made by physicists or botanists. The optical treatises of Stokes gave important hints regarding the existence of two components of chlorophyll, while Borodin made fascinating microscopical observations.

Twenty-two years ago Willstätter published his first paper on chlorophyll. Since then he and his collaborators have deduced the characteristics of its constitution from a consideration of the derivatives that were formed upon reaction with acids and alkalies. In a few years they obtained pure chlorophyll (1911) but learned practically nothing new regarding its chemical or physical properties. Chemically, chlorophyll was found to be composed of carbon, hydrogen, oxygen, nitrogen and magnesium, and formulae have been given for chlorophyll *a* and chlorophyll *b*. These formulae are only tentative and much more work is needed to ascertain the exact chemical formula for each of the two components. There seems to be no doubt that chlorophyll and hemin each contains four pyrrol nuclei, yet how these nuclei are linked together in the molecule is a matter for much further consideration.

*Willstätter's Search for Chlorophyll*

The story of the search for chlorophyll is indeed a very fascinating one. It also is the record of a man who attempted and accomplished what chemical workers of an earlier day said was impossible.

Much of the work was very laborious and the yields must often have been most disheartening. This was especially true of his first attempts to obtain chlorophyll by methods of fractionation. His work can not be fully appreciated unless something is known regarding the amount of materials used and the number of men assisting him. In all more than eighteen highly trained investigators assisted him in the work on chlorophyll. For more than seven years several men working at the same time were actively engaged in solving the chemical nature of chlorophyll. It was in 1911 that the tremendous amount of labor which he and his coworkers had put forth was crowned with

success. It was then that pure chlorophyll was first isolated. To-day, chlorophyll can be isolated from living or dried leaves, and the methods have been developed so that we may obtain the pure green pigment in amounts sufficient for any purpose.

It probably will be a revelation to even those who have been most interested in chlorophyll to know what vast quantities of material were necessary in the study of chlorophyll and its derivatives. In working on the derivatives, phytochlorin and phytorhodin, lots of ten and twenty-three kilograms of ground nettle-leaves were used in a single extraction. In a further study of the composition of chlorophyll in which magnesium was found to be present instead of phosphorus, iron or potash fifty kilograms of leaf-meal were used at one time. In the preparation of pheophytin, lots of one hundred and four hundred kilograms of leaf-meal were extracted. In all eight hundred and sixty grams of phytol were obtained from three kilograms of pheophytin, which was obtained from more than one thousand kilograms of dried leaves. Even then the chemistry of phytol was not successfully accomplished and at a later time another worker again undertook more work on the chemistry of phytol. To-day, even more can be learned about phytol. To work out the chemistry of rhodophyllin, 40- to 70-kilogram-lots of leaves were used. One hundred-kilogram-lots were used in learning what we know about the phyllins. I have said nothing yet about the number of one-, two-, ten- and twenty-kilogram-lots of leaves used in obtaining information regarding: ethyl chlorophyllide from thirty-five different plants, the fractional separations carried out in the isolation of the two components of chlorophyll, the preparation of chlorophyll, pheophytin and phytol from seventy species of various classes of plants, the quick and slow extraction of the chlorophyll of more than two hundred species of plants of many classes in order to compare the amount of phytol present in the chlorophyll obtained or of many of the other phases of the investigations on chlorophyll. As yet I have not even mentioned the amount of materials that must have gone down the sink.

It would be very difficult indeed to give even a rough estimate of the vast amount of solvents used in the study of chlorophyll. Petroleum ether, methyl and ethyl alcohol, acetone and ether were used by the barrels and possibly by the carloads. Let us take one example:

In obtaining pure chlorophyll from one kilogram of dried leaves about six liters of acetone, seven of petroleum ether, one of ether and four of methyl alcohol are necessary. To fractionate eight grams of chlorophyll into chlorophyll *a* and chlorophyll *b* about ten liters of ether, forty-five liters of methyl alcohol and fifteen liters of petroleum ether are required. When you get through with the fractionation you may or you may not have chlorophyll *a* and chrolophyll *b*, all depending upon how well you know and use your knowledge of the nature of chlorophyll.

I have purposely given the separation of chlorophyll *a* from chlorophyll *b* as an example, for here is where we are going to have to begin to learn more about chlorophyll, by studying its two components each in the pure state. Most of the work on chlorophyll is simple and easy when compared with the fractionation of the two components, but even yet the amount of organic solvents necessary is quite large.

At first, the preparation of pure chlorophyll was as difficult an undertaking as is now the separation of the pigment into its two components, for it was a fractionation method. The discovery, that chlorophyll of a certain degree of purity is not soluble in petroleum ether when free from alcohol, led to the easy preparation of pure chlorophyll and there is no reason to believe that some day chlorophyll *a* and chlorophyll *b* may not be easily separated or if not easily separated they will be easily determined quantitatively, which should greatly aid us in the solution of problems concerning chlorophyll.

### *The Absorption Spectra of Chlorophyll and its Derivatives*

Willstätter has given us many measurements of the absorption spectra of chlorophyll and its derivatives. Two methods were used to obtain these results—the photographic and visual. Willstätter says that a comparison of the photographs and diagrams convinces us that photographic reception and representation of the spectra are not, as is generally assumed, a method possessing greater objectivity than observations with the eye and graphical reproduction of the measurements that are thus obtained. The photographic method is also characterized by considerable subjectivity which is conditioned by the sensitiveness of the plate, the illumination, the procedure and by the reproduction. Even though photograms reproduce all the observed absorption bands correctly according to their position, nevertheless their boundaries and relative intensities are somewhat less exactly shown than in the case of direct observation with the eye, the sensitiveness of which exceeds that of the photographic plate.

Since the days when the work on chlorophyll was completed, tremendous advances have been made by the bureau of standards in measuring the absorption spectra of solids and of liquids. The optical transmissive and absorptive properties of solutions of dyes are of primary and fundamental importance in practical analysis and identification as well as in theoretical

studies of chemical constitution. Much work has already been done on this subject, but the results are largely qualitative or only crudely quantitative. Observations made of the edges of the absorption bands at different concentrations or thicknesses are only roughly quantitative. It is only in very recent years that any work of an exacting nature has been done and practically all of this has been done at the Bureau of Standards.

At the present time four methods of measuring the spectral transmissive properties of dyes have been developed. These methods cover the range from 240 to 1,360 millimicrons. The work done by Willstätter covers only the visible spectrum, four hundred to seven hundred millimicrons. The photographic method with the Hilger sector photometer covers the range 240 to 500; the photoelectric null method covers 380 to 600; the visual, using the König-Martens spectrophotometer, 436–710 and the thermoelectric method covers 600–1,360. Consequently, methods are now available for studying very accurately the absorptive properties of chlorophyll in the ultra-violet and infra-red regions of the spectrum as well as in the visible.

Plant physiologists have done practically nothing in the way of an exact study of factors affecting even the visible portion of the chlorophyll spectrum. That portion of the spectrum beyond the visible region has hardly been given the slightest serious consideration. The plant physiologist needs to know everything that can possibly be known regarding the absorption curve for chlorophyll. Our knowledge by all means should extend into the regions beyond the visible, for who knows what may be discovered. After the spectral transmissive properties of chlorophyll from 240–1,360 mμ are very accurately known, then and then only can we begin to study the exact effect of any given wave-length of light upon the chlorophyll molecule. The effect of each wave-length should be studied before we can say that we know very much regarding the effect of light upon chlorophyll formation or decomposition. Practically all we now know about light and chlorophyll is concerned with the mass-effect of visible light upon a mass of chlorophyll, which has not even been quantitatively determined. There is a tremendous opportunity for study in this field. Of course many obstacles will have to be overcome, but they are evidently not so unconquerable as was the preparation of chlorophyll for so many years. The instruments are available and chlorophyll of sufficient purity can be prepared, so there is no real reason why work on this important problem should be longer delayed. It is a problem of pure science and one that is fundamental in plant physiology and bids fair to offer its share of intellectual and spiritual contributions to the welfare of mankind.

The problem becomes all the more interesting when we consider that chlorophyll is being continually formed and broken down in plants. By such a consideration very much more chlorophyll is involved in the growing season than we have been generally led to believe. This fact alone would tremendously increase the importance of chlorophyll and would lead us to suspect that chlorophyll is perhaps something more than we had formerly considered it to be. When we consider that about one per cent. of the dry weight of green leaves is chlorophyll, then and then only do we begin to realize the enormous amount of chlorophyll which is produced annually by all green plants. The amount produced then must be several per cent. of the weight of the dry organic matter produced per year by green plants.

### B—Vitamins

#### *History of the Chemical Nature of Vitamins*

Ninety-four years after Pelletier and Caventou (1818) proposed to call the green pigment present in plants chlorophyll, Funk proposed the name vitamin for substances which were necessary in a complete diet. Seventeen years ago, the year (1911) that Willstätter first prepared pure chlorophyll, Funk claimed to have isolated vitamin B from rice-polishings. The evidence indicated that it was a crystalline nitrogenous compound belonging to the pyrimidine group and that it was possibly a constituent of nucleic acid. One year later oryzanine was obtained and was found to contain carbon, hydrogen, oxygen and nitrogen. Attempts have been made to isolate vitamin A from cod-liver oil and analysis of the products obtained gave only carbon, hydrogen and oxygen; nitrogen was not found. Funk, however, feels that in the interest of future investigation the question regarding the presence of nitrogen in vitamin A should be left open. Attempts at preparing pure vitamin B have been made by several workers, but as yet the pure product has not been obtained. Analysis of the products seems to show that it contains carbon, hydrogen, oxygen and nitrogen; workers seem to agree that the compound is of a cyclic nature.

At the present time about all that can be said is that no one as yet has been able to isolate a vitamin in pure form. In regard to the chemistry of vitamin, little of real significance has been accomplished. The chief advances, however, have been made in regard to their physical properties. We do not even know what they look like, whether they are crystalline or amorphous substances, whether they have color or taste. Some one has said that the vitamins may even be a form of energy and not a substance at all. Our knowledge about vitamins consists chiefly of their

effects upon animals. It is known that they are present in practically all plant-products though often in only very minute quantities. The greatest progress has been made in regard to our knowledge of their presence in food-products. They seem to play a very different rôle in nutrition from the other food-constituents. They regulate and control certain vital processes in the animal organism. Fractions having high-vitamin concentrations have been obtained by various investigators from cod-liver oil, from yeast and from rice-hulls. Fractions ten thousand times the original concentration in cod-liver oil have been obtained. In spite of this high degree of concentration we are far removed from the isolation of the various vitamins and the determination of their chemical composition. A host of investigators, however, have established that these chemically-unknown substances are of vital importance.

Since there are no known chemical tests for the vitamins, progress in their isolation depends largely upon the success of the physiological tests available for guiding the fractionation. Improvement in the accuracy and rapidity of these tests is undoubtedly a matter of great importance.

During the past few years there has been a revival of the interest in the chemistry of vitamins. Attempts have been made at isolating A, B and D in crystalline form. Many years have been required to obtain these elusive compounds even in the state of purity now reported. Seidell looks forward to the synthesis of the vitamins and to their extensive application to the nutritional needs of man.

### *The Search for Vitamins*

Only a part of the story of the search for vitamins can be written, for these substances have not yet been isolated in pure form. The work has always been very laborious and the yields have been anything but encouraging.

In 1911, Funk reported the results of his attempts in isolating 0.4 grams of a colorless crystalline substance from fifty kilograms of rice-polishings obtained from Malay. Later from 380 kilograms of the polishings he obtained 2.5 grams of the crude product which contained vitamin B. His analysis showed that nitrogen was present in the product obtained. From seventy-five kilograms of dried yeast he obtained 0.45 grams of colorless needles and from one hundred kilograms of yeast 2.5 grams of crude product containing vitamin B was obtained. This product produced 1.6 grams of crystals.

After repeated trials crystals of oryzanine picrate have been obtained from three hundred grams of fat-free rice-bran. Vitamin B has been sought from several other sources. Seidell has modified the method of obtaining vitamin B several times, but as yet only a crude product has been produced. Synthetic experiments have been resorted to by Williams and Seidell, but to date nothing definite has been found regarding vitamin B.

From 25-kilogram-lots of cod-liver oil, attempts have been made to obtain vitamin A, but as yet only crude fractions have been obtained. Cod-liver oil is probably the only substance from which attempts have been made to isolate vitamin A. Some even are led to suspect that the vitamin is present only as impurities in the fractions which have been obtained. It is known that codfish do not synthesize vitamin A. The vitamin has been found to come from the food of the codfish, which is small fish. The small fish feed on plankton, which consists of copepods, and the copepods live on diatoms, which have been shown to be able to synthesize vitamin A. At the present time many observations point to the conclusion that only plants which contain chlorophyll are able to produce vitamin A. Vitamin A may be present in many food-products, but its ultimate origin seems to be chlorophyll-containing plants.

No exhaustive attempt as yet has been made to isolate vitamin C. Fractions containing vitamin D have been obtained from malt-house combings and from yeast. Other vitamins have been reported, but nothing at all definite is known regarding their chemical nature, for as yet no attempt has been made to isolate them.

There are several reasons why it is so difficult to obtain the vitamins in a pure state. The starting materials, such as cod-liver oil, yeast and rice-hulls, are very complex materials from which it is possible to isolate many organic compounds. The vitamins are present in only very minute quantities in any raw material. Cod-liver oil can be fractionated so that there is ten thousand times as much in a given sample as there was in the original material. If we consider that the concentrated fraction containing vitamin is pure vitamin, then the vitamin present in the original cod-liver oil must have been less than one hundredth of one per cent. Since we are quite positive that the fraction was not pure vitamin, then we can be just as positive that the amount of vitamin present in the original material must be very small indeed. Of course the laboratory reagents and manipulations destroy or lose much of the original vitamin. At the present time no color or chemical tests are known which will aid in the various steps of purification. Feeding experiments, which require much time, are used and these rarely give uniform results.

The most urgent problem at the present time seems to be concerned with the chemical nature of the vitamins, for only when reasonably pure preparations

of the active substances are available can we expect to gain a clearer knowledge of their physiological action upon the human body. The medical practice to-day is sorely in need of just such knowledge as only the study of vitamins in a pure state will give.

### *Value of Vitamin Studies*

Since practically every person is somewhat familiar with vitamins little need be said about the value of studying them. Vitamins are believed to eliminate certain specific diseases such as beriberi, scurvy, rickets and many others. Vitamins are generally believed to reduce the prevalence of many other diseases and greatly increase the resistance of the human body to all kinds of infection. Even sterility is believed to be produced by a lack of one of the vitamins. As to their exact value in bodily metabolism, medical science is not yet prepared to tell us. Vitamins are not only of interest to men of science and of medicine, but to those engaged in political economy. The recent world war, which greatly interfered with the normal movement of foodstuffs and consequently caused the wretchedness of stricken Europe, is only one striking example.

Just how valuable the vitamins are in animal economy we yet have very little knowledge. In regard to the value of the vitamins in plant-economy we are completely in the dark. Funk and many others would like to know the rôle of vitamins in the vegetable kingdom, which means that we must know their rôle in plant physiology. When we have isolated and are able to use pure vitamins in our scientific investigation on plants and animals then we will be able to discuss very ably the value of vitamins and their rôle in nature. There seems to be every reason to believe that vitamins are very intimately concerned in the rôle of all organic life. A most fundamental study of their chemistry and rôle in nature then should be thoroughly in harmony with progress in pure science, and any avenue suggested leading to their possible isolation should be seriously considered.

## CONCLUSION

Any one interested in light, in chlorophyll or in the vitamins should not fail to learn all they can regarding the interrelation of these subjects. The chemist, the physicist and the plant-physiologist should each be interested from the bearing these subjects have upon one another and also upon his own field. To say that no relation exists only reveals our ignorance and we as scientifically-minded men can say that no relation exists between these subjects only after we know much more about them. At present we all must confess that our knowledge regarding these subjects is very elemental. Funk believes that most of the problems discussed by those interested in vitamins have only been scratched on the surface, due to the fact that such slow progress has been made in the chemistry of the vitamins. The exact nature of light, of chlorophyll and of the vitamins is as yet foreign to our knowledge.

Reports on the isolation of pure chlorophyll up to the day of Willstätter have been only reports of failures, and to date all attempts to isolate a vitamin have met with the same fate. Many of the problems which Willstätter undertook and solved would have thoroughly disheartened many of the most seasoned investigators. Attempt after attempt to ascertain the real nature of the vitamins have only met discouragement. But since wise men know that failures are the greatest stepping-stones to success in any endeavor we now find ourselves in a position to strive harder than ever to unravel the real nature of that which we would know.

I have attempted to review in a very brief way our knowledge of the chemistry of the vitamins and of chlorophyll, and at the same time show the great amount of work necessary to find out what little we now know regarding these subjects. The isolation of chlorophyll from plant-tissue undoubtedly will be an easy matter when compared with the isolation of vitamins from raw materials. Chlorophyll is highly colored and relatively abundant in plant-tissue while vitamins are present in only very small amounts and are probably colorless or only slightly colored. Color changes in the isolation of chlorophyll tell us instantaneously when we have altered the molecule, but we have no such guide in the isolation of a vitamin. No investigator can say when we will be able to isolate a pure vitamin from the raw materials in which it is found. Any study of the chemistry of vitamins knows that their isolation is confronted with many obstacles which as yet have not been overcome.

I have presented an hypothesis which undoubtedly many will say is misleading. To them I can say that often in science some of the most misleading hypotheses have led to favorable solutions of many scientific questions. At any rate, we all can say that if the subjects discussed herein remain quiescent, progress will never be made. We solve only the problems which we most actively think about, and certainly these subjects are worthy of our concentrated thought.

In the world of inorganic chemistry the atom is as complicated as the solar system and has its own microscopic astronomy of electrons. In the world of organic chemistry, chlorophyll is about as complicated a substance as can be found. In ordinary

chemical processes the whole atom gets heated when electrons shift. But the right radiation or an electron stream of the right velocity will loosen the electrons without wasting energy in heating up the mass of the atom. Now the green leaves of plants are marvels of efficiency in using directly the light of the sun to form organic matter. Somehow, nobody knows just how, sunlight causes electronic shifts which tie the atoms to form all sorts of organic substances. The plant grows, develops and so we have more organic matter of all kinds. It is the most fundamental mysterious reaction in nature and one on which our food and our lives depend. Chemists have not yet duplicated such a silent efficient process. The atom is the key to many chemical problems of to-day and chlorophyll has a very good chance of becoming the key to much which concerns all living processes. Who among us is prophet enough to say what the chemistry of to-morrow will be?

We now know what master chemists can do with the atom, for from it they get power-radio, television, the vitaphone and thousands of other wonders. We know what a master chemist can do in the way of analyzing chlorophyll and breaking it up into the components, but what we want to know is how the Great Master Chemist of the Universe very quickly and so quietly produces such large amounts of organic matter, nitrogen-compounds in particular which we as investigators are now considering as the basis of all life as we know it.

Men everywhere are spending huge sums of money to make practical applications of discoveries which have been made in the field of pure research. Our advance, however, will be measured not so much by the practical applications we make, for practical applications are comparatively easy, as by the progress we make seeking knowledge regarding fundamental things, of which we are now in almost complete ignorance. If chlorophyll is in any way related to the vitamins and if the vitamins play as large a rôle in maintaining health as they are assumed to play, then certainly a knowledge of chlorophyll will do something to reduce the $15,000,000,000 annual loss of this nation due to sickness alone. The problem of pure research is not so much a problem of getting or giving of money as it is of getting workers who passionately give of themselves in the pursuit of truth for truth's sake. The most essential quality of an investigator is the spirit within and this quality is not purchasable with money.

F. M. Schertz

U. S. Department of Agriculture,
Washington, D. C.

## SCIENTIFIC EVENTS

### THE AMERICAN STANDARDS ASSOCIATION

Reconstruction of the American Engineering Standards Committee to keep pace with the growth of the industrial standardization movement in the United States is now under way, according to an announcement by the committee. The principal features of the reconstruction are the definite federation of national organizations, under the name American Standards Association, in such a way that trade associations interested in standardization may more readily join in the direction of the movement; placing the technical work of approving standards in a standards council, and concentrating administrative and financial responsibility in a board of directors composed of twelve industrial executives.

The reorganization has been unanimously approved by the main committee of the A. E. S. C., and is now being voted upon by the membership. The action of the committee results from more than a year's intensive consideration of the subject by the main committee and rules committee. The latter was enlarged for the purpose to include a representative of each of the 19 member-bodies desiring representation.

Among the conditions which led to the reorganization are the growth of the trade association movement together with the predominating position which the trade association is coming to have in the field of industrial standardization, and the increasingly important direct part which the plant executive is playing in the standardization activities within his plant and in the movement as a whole. Recognition of this latter condition is reflected in the make-up of the board of directors, which will control the general administrative and financial affairs of the association. The industrial executives composing this board will be elected on nomination of member-bodies and will serve for three years.

Approval of standards and matters of procedure will be in the hands of a standards council. The council will be composed of not more than three representatives of each of the member-bodies, the councilors also serving for a period of three years.

The objects of the association, as stated in the new constitution, will be: To provide systematic means by which organizations engaged in industrial standardization work may cooperate in establishing American standards in those fields in which engineering methods apply, thus avoiding duplication of work and the promulgation of conflicting standards; to serve as a clearing house for information on standardization work in the United States and foreign countries; to further the industrial standardization movement as a

means of advancing the national economy, and to promote a knowledge of, and the use of, approved American industrial and engineering standards, both in the United States and in foreign countries, and to act as the authoritative channel in international cooperation in standardization work, except in those fields adequately provided for by existing international organizations.

## THE STUDY OF RADIATION AT CORNELL UNIVERSITY

THE Heckscher Foundation for the Promotion of Research in Cornell University has awarded grants amounting to $34,550 to members of the Cornell faculty for the year 1928–29 for a concentration of effort on a single field of research—radiation.

While considerable research has already been done in this field by individual members of the departments of physics and chemistry at Cornell, the new program involves for the first time the full cooperation and interchange of facilities of both departments. Twelve professors and a large number of assistants will engage in nine major projects, each of which will concern itself with radiant energy of a particular wavelength ranging from the visible or short light rays to the invisible radio wave of unusual length.

The Heckscher research council's plan involves the cooperation of the Cornell departments of physics and chemistry. Both departments were already engaged in a number of researches in the field of radiation. These studies have been coordinated, other studies are being planned to strengthen the whole program and the work will proceed as a unit.

Following is an outline of the investigations proposed to be carried on, some of them jointly, by the departments of physics and chemistry:

1. Professor F. K. Richtmyer, of the department of physics: X-rays. In particular, X-ray spectra and the absorption of X-rays by different materials.

2. Professor C. C. Murdock, of the department of physics: The use of X-rays in studying the size and shape of colloidal particles. And, in cooperation with Professor T. R. Briggs, of the department of chemistry, it is planned to use the same method in the study of catalytic agents.

3. Professor W. D. Bancroft, of the department of chemistry, researches in photochemistry as follows: The chemistry of radicals; the action of light on catalytic agents; the theory of photochemical reactions. In addition, Professor Bancroft will collaborate with Professor J. R. Johnson, of the chemistry department, in a study of the synthesis of optically active substances.

4. Professor R. C. Gibbs, of the department of physics: Spectroscopy. The study of line spectra, especially in the extreme ultra-violet. Professor Jacob Papish, of the department of chemistry, will assist in supplying pure materials.

5. Professor John R. Johnson (chemistry) and Professor R. C. Gibbs (physics): The absorption of visible and ultra-violet light by different materials, and the relation between absorption and chemical constitution.

6. Professor M. L. Nichols (chemistry) and Professor Ernest Merritt (physics), in cooperation with Professor E. H. Kennard (physics) and Professors Johnson and Papish (chemistry): Luminescence. In particular, the relation between phosphorescence and fluorescence and the chemical constitution of different materials.

7. Professor J. R. Collins (physics): Emission and absorption in the infra-red. The first experiments planned deal with the effect of extremely high pressures on absorption—an entirely new field.

8. Professor Merritt (physics): The use of short radio waves in studying the conditions in the upper part of the atmosphere. Apparatus loaned to Professor Merritt by the Magnetic Observatory of the Carnegie Institution has been set up and will be used for observations of the reflection of short radio waves by the upper atmosphere, and valuable cooperation is assured from the Bell Telephone Laboratories, the General Electric Company and the Carnegie Magnetic Observatory. Similar cooperation is expected from the United States Navy and from certain stations in foreign countries as soon as it is needed.

9. Professor Frederick Bedell and H. J. Reich (physics): Alternating current investigations. Several of the problems proposed have a direct bearing upon the experimental methods used in the other parts of the general program.

## AWARDS FOR SCIENTIFIC EXHIBITS BY THE AMERICAN MEDICAL ASSOCIATION

AWARDS for scientific exhibits made in connection with the recent meeting of the American Medical Association were made as follows:

### CLASS I

[Awards in Class I are made for exhibits of individual investigations which were judged on basis of originality and excellence of presentation.]

The gold medal to Edward Francis, U. S. Public Health Service, Washington, D. C., for his thorough and important scientific contributions to the knowledge of tularemia, illustrated by his exhibit.

The silver medal to Eben J. Carey, Marquette University Hospital, Milwaukee, for an exhibit showing the results of excellent experimental work on the dynamics of origin, structure and repair of bone.

The bronze medal to Adelbert Ames, Jr., and Gordon H. Gliddon, Dartmouth Medical School, Hanover, N. H., for exhibit showing significant application of physics to ophthalmology.

Certificates of merit, Class I, to the following (alphabetically arranged):

B. J. Clawson, University of Minnesota, Minneapolis, for an exhibit emphasizing clinical and experimental phases of the study of endocarditis.

Richard E. Scammon, University of Minnesota, for exhibit illustrating growth and structure of the human body.

Harry Steenbock, University of Wisconsin, for an exhibit illustrating the results of studies of vitamin D.

CLASS II

[Awards in Class II made for exhibits which do not exemplify purely experimental studies, and which were judged on the basis of the excellence of correlating facts and excellence of presentation.]

The gold medal to Walter M. Simpson, Miami Valley Hospital, Dayton, Ohio, for exhibit of the gross and microscopic changes in tularemia and for excellence of presentation.

The silver medal to Arthur J. Bedell, Albany, N. Y., for an instructive exhibit of stereophotographs of the living eye.

The bronze medal to O. E. Denny, National Leprosarium, Carville, La., for excellent exhibit of color photographs illustrating various manifestations of leprosy.

Certificates of merit, Class II, to the following (alphabetically arranged):

John O. Bower and Jefferson H. Clark, Samaritan Hospital, Philadelphia, for exhibit of skin prints in the diagnosis of cancer of the breast.

Dr. T. Horton, Mayo Clinic and Foundation, Rochester, Minn., for exhibit illustrating pyloric block.

David Steel, Cleveland City Hospital and Western Reserve University, Cleveland, for exhibit illustrating roentgenologic and anatomic observations in cardiac diseases.

Honorable mention was made to the following:

C. Latimer Callender, San Francisco, and Cyrus Newton Callender, Fargo, N. D., for exhibit of surgical anatomic drawings.

James T. Case and W. O. Upson, Battle Creek, Mich., for roentgenographic exhibit of cholecystography.

Robert A. Moore and Earnest Scott, Ohio State University, Columbus, Ohio, for exhibit illustrating cardiovascular diseases.

Leo G. Rigler, University of Minnesota, for exhibit showing relation of esophagus and heart and aorta.

Fred D. Weidman, Zoological Society of Philadelphia, for exhibit illustrating comparative helminthology.

The committee made special mention of Benjamin Terry, Albert E. Sterne and Harry Spiro, for the excellence of personal demonstrations.

EDUCATIONAL EXHIBITS

A special certificate of merit was awarded to the U. S. Pharmacopeial convention for the best exhibit in the educational (national organizations) classifications. Mention was also made of the exhibit of the Committee on the Grading of Nursing Schools.

## NATIONAL RESEARCH FELLOWSHIPS IN THE BIOLOGICAL SCIENCES

THE Board of National Research Fellowships in the Biological Sciences, in meeting on May 25 and 26, awarded fellowships to the following individuals:

*Reappointments*

Dean Turner Burk, Biochemistry
David R. Briggs, Zoology
James M. Fife, Botany
Frederick H. Frost, Botany
Theodore F. Karwoski, Psychology
E. A. Swenson, Zoology

*New Appointments*

J. A. Gengerelli, Psychology
Helen A. Purdy, Botany
Malcolm R. Irwin, Zoology
Attilio Rizzolo, Psychology
D. H. Nelson, Botany
Morgan Upton, Psychology
L. H. Warner, Psychology
Wayne N. Plastridge, Botany
Samuel E. Hill, Zoology
Anna H. Gayton, Anthropology
Robert C. Robb, Zoology

The first meeting of the coming year for the consideration of applications for 1929–30 appointments, both American and foreign, will be held around the first of February. Applications for this meeting should be received by the latter part of December.

FRANK R. LILLIE, *Chairman,*
*Board of National Research Fellowships in the Biological Sciences*

## SCIENTIFIC NOTES AND NEWS

DR. E. G. CONKLIN, professor of biology at Princeton University, will give the seventh William Thompson Sedgwick memorial lecture at the Marine Biological Laboratory, Woods Hole, on July 27. Dr. Conklin's subject will be "Problems of Development."

THE gold medal of the Linnaean Society of New York, awarded to Dr. C. Hart Merriam, research associate of the Smithsonian Institution, was presented to Dr. Merriam by Dr. Frank M. Chapman, of the American Museum of Natural History, on May 30.

DR. HERBERT OSBORN, research professor at the Ohio State University, by vote of the fellows of the Entomological Society of America has been elected to honorary fellowship in the society. Other honorary fellows are C. J. S. Bethune, J. H. Comstock, S. A. Forbes, L. O. Howard and E. A. Schwarz.

DR. HUGH S. CUMMING, surgeon-general of the United States Public Health Service, has been elected a corresponding member of the Royal Society of Medicine of Great Britain for "meritorious work and ability as a scientist and leader in public health affairs."

DR. THOMAS BARBOUR, director of the university museum at Harvard University, has been elected an honorary member of the Phi Beta Kappa Society.

On the occasion of the celebration of the centenary of its foundation on July 11, the Sheffield Medical School conferred the honorary degree of D.Sc. upon Dr. H. H. Dale, Professor Arthur J. Hall, Sir Frederick Gowland Hopkins, Sir Thomas Lewis and Professor Otto Warburg.

Dr. Fay-Cooper Cole and Dr. and Mrs. George Dick were given honorary degrees of doctor of science by Northwestern University on June 18 and not by the University of Washington as was incorrectly reported in Science.

At the recent annual meeting of the Association for the Study of the Internal Secretions in Minneapolis the following officers for 1928–29 were elected: *President,* Dr. Oscar Riddle, Cold Spring Harbor, N. Y.; *first vice-president,* Dr. Peter Bassoe, Chicago; *second vice-president,* Dr. Edgar Allen, Columbia, Mo.; *secretary-treasurer,* Dr. F. M. Pottenger, Monrovia, Calif.

Dr. W. R. Whitney, director of the research laboratory of the General Electric Company, and Dr. Samuel W. Stratton, president of the Massachusetts Institute of Technology, are the two civilian members of a committee of five appointed by Secretary Wilbur to study submarine devices and salvage.

Dr. Charles Beach Atwell, professor of botany at Northwestern University, has retired from active teaching after having served as a member of the faculty for almost fifty years. He was the oldest member of the faculty in point of service.

Dr. Forman T. McLean has resigned as head of the plant physiology department of the Agricultural Experiment Station at the Rhode Island State College.

Professor Hermann Diedrichs, director of the Sibley School of Mechanical Engineering at Cornell University, has been appointed to the newly established John E. Sweet professorship in mechanical engineering in the university.

Dr. J. Gordon McKay, of the U. S. Bureau of Public Roads, will leave the government service to head the new Cleveland Bureau of Highways Research, formed to carry out a $60,000,000 road program.

Dr. John Farquhar Fulton, who during the past two years has been working in Dr. Harvey Cushing's clinic at the Harvard Medical School, has received a three-year appointment to a research fellowship at the University of Oxford, where he will carry on research in physiology under Sir Charles Sherrington, and write on the history of physiology and the bibliography of the works of Robert Boyle.

Reorganization in the division of plants of the U. S. National Museum, due to the recent death of Dr. J. N. Rose and the resignation of Paul C. Standley, is taking place. Ellsworth P. Killip has been appointed associate curator and Emery C. Leonard assistant curator. Egbert H. Walker, a graduate of the University of Michigan and of the University of Wisconsin, has been temporarily appointed aid. For four years Mr. Walker was connected with the Canton Christian College, Canton, China, and he will have charge of the large collections of Chinese plants in the National Herbarium.

Dr. Lee E. Miles, assistant professor of plant pathology at the State College of Washington and assistant plant pathologist in the Washington Agricultural Experiment Station, has been appointed to succeed Dr. D. C. Neal as plant pathologist at the Mississippi Agricultural Experiment Station.

Paul Gerlaugh, animal husbandry specialist in the University of Ohio, has been appointed chief of the department of animal industry in the experiment station in the place of Dr. G. Bohstedt, who recently resigned.

Ray Edward Stadelman, of the University of Kentucky, has joined the staff of the Antivenin Institute of America, a division of the Mulford Biological Laboratories at Glenolden, Pa. He will work with Dr. Thomas S. Githens, assistant director of the institute, in the preparation of the venom for immunizing horses and in the production and testing of the specific antivenins.

H. W. Hoots has resigned from the U. S. Geological Survey to engage in petroleum engineering with the Union Oil Company, Los Angeles.

Dr. James Davidson, chief assistant entomologist of the Rothamsted Experimental Station, England, has been appointed head of the department of entomology at the Waite Agricultural Research Institute, the University of Adelaide.

Professor A. Frumkin, of the Karpow Institute of Chemistry at Moscow, has been appointed visiting professor of colloid chemistry at the University of Wisconsin, where he will give a course of lectures in colloid chemistry and direct researches in that field.

Dr. W. D. Matthew, professor of paleontology at the University of California, is making a two months' visit to the American Museum of Natural History in order to continue his studies of its Paleocene collections.

John P. Harrington, of the Bureau of American Ethnology, left Washington on July 11 to continue his studies of the Mission Indians of California.

DR. WILLIAM R. MAXON, associate curator of the division of plants in the U. S. National Museum, sailed for Europe on July 4 to study the fern collections at several of the larger herbaria. He is planning to spend several weeks at the British Museum (Natural History) and at the Royal Botanic Gardens, Kew, in completing the manuscript of the fern volume of the Flora of Jamaica, now in course of publication by the British Museum. From London Dr. Maxon expects to go to Copenhagen, Stockholm, Berlin and Paris.

DR. SAMUEL R. WILLIAMS, professor of physics at Amherst College, has been granted a leave of absence for the year 1928–29, which will be spent in Cambridge, England.

A. H. MILLER, of the Dominion Observatory, sailed for England on June 8 to study the torsion balance in association with the Geological Survey of Great Britain, on behalf of the Geological Survey of Canada as well as of the Dominion Observatory. He will also make measurements of gravity at London and Berlin, with the instruments used for this work in Canada, and the comparative measures will be of value in studies of the earth's figure.

DR. C. E. KENNETH MEES, director of the research laboratory of the Eastman Kodak Company, gave on July 12 the fourteenth lecture in the series arranged by the British Institute of Physics on "Physics in Industry," with the cooperation of the seventh International Congress of Photography.

DR. PLINY EARLE GODDARD, curator of the department of anthropology at the American Museum of Natural History, died on July 13 in his fifty-ninth year.

DAVID CHARLES DAVIES, director of the Field Museum of Natural History, died on July 14, aged sixty-two years.

DR. GEORGE PORTER PAINE, professor of physics at the University of Delaware, died on June 5, aged fifty-one years.

DR. WALTER BOOTH ADAMS, professor emeritus of pharmacology, therapeutics and dermatology, in the American University at Beirut, Syria, has died at the age of sixty-four years.

PROFESSOR JOHANNES GADAMER, director of the Pharmaceutical-Chemical Institute in the University of Marburg, died on April 15 at the age of sixty-one years.

THE United States Civil Service Commission announces an examination for associate physiologist at a salary of $3,600, applications for which must be received not later than August 8.

WITH an attendance of about 240 the Sixth Colloid Symposium concluded a three-day meeting at the University of Toronto on June 16. The seventh symposium will meet at the Johns Hopkins University, from June 21 to 23, 1929.

THE twelfth annual summer meeting of the Mathematical Association of America will be held at Amherst College, Amherst, Massachusetts, on September 3 and 4. Professor B. H. Camp, of Wesleyan University, is chairman of the program committee.

THE thirteenth annual meeting of the Optical Society of America will be held at the Bureau of Standards in Washington, from November 1 to 3, 1928. It is expected that this will be the largest meeting in the society's history. In addition to the usual program of papers contributed by members on their own initiative, it is intended to have a well-balanced program of invited papers on various outstanding topics in optics. The exhibition will be held under the joint auspices of the Bureau of Standards and the Optical Society. It will open October 31, the day before the meeting, and will be open from 9: 00 A. M. to 4: 30 P. M., October 31–November 3 and one evening to be designated later.

DR. JOHN JOHNSTON, director of research and technology of the United States Steel Corporation, C. A. Reinhardt, chief metallurgist of the Youngstown Sheet and Tube Company, Dr. A. J. Unger, manager of the research bureau of the Carnegie Steel Company, and Homer D. Williams, president of the Pittsburgh Steel Company, have been invited by President Thomas S. Baker to become members of the advisory board of the department of metallurgical engineering at Carnegie Institute of Technology. The advisory board, which is composed of about 25 steel company executives and metallurgists, is concerned primarily with the development of metallurgical research as now carried on jointly by the Carnegie Institute of Technology and the U. S. Bureau of Mines.

THE malaria commission of the League of Nations met in Geneva, June 25, for the purpose of formulating a European campaign against malaria, according to a memorandum of the League of Nations. The commission was established in 1924 to endeavor to wipe out malaria, which had become prevalent during the World War. The commission has studied malarial problems in the United States in cooperation with the Public Health Service.

A COMMITTEE of Germans, representing agriculture, industry and finance, has asked a group of Americans to work with a group of Germans during this summer on a commission for the study of the marketing of farm products, particularly dairy products and meats.

The American members of the commission are: Dr. G. F. Warren, professor of agricultural economics and farm management, Cornell University, *chairman;* C. E. Gray, president, Golden State Milk Products Company, San Francisco; Dr. N. W. Hepburn, manager, Peoria Creamery Company, Peoria, Ill.; J. Clyde Marquis, economist in charge of economic information in the U. S. Bureau of Agricultural Economics; Dr. F. B. Morrison, director, New York State Agricultural Experiment Station, Geneva, N. Y.; Dean H. W. Mumford, College of Agriculture, University of Illinois; Dr. F. A. Pearson, professor of prices and statistics, Cornell University; Dr. H. A. Ross, professor of marketing, Cornell University; Dr. Otto Rahn, professor of dairy bacteriology, Cornell University, and I. C. Weld, production manager, Chestnut Farms Dairy, Washington, D. C. The commission planned to begin its work at Berlin about July 15.

The scientific work of Commander Richard E. Byrd's forthcoming expedition to the Antarctic is to be under the auspices of the American Museum of Natural History. A special room has been set aside in the school service building as scientific headquarters of the expedition, and experts of the museum staff will assist Commander Byrd and his staff in outlining a program of scientific activities. Professor Henry Fairfield Osborn gave a luncheon at the museum on June 4 in honor of Commander Byrd.

The investigational work on board the non-magnetic yacht *Carnegie,* which left Washington, D. C., on May 1, on her seventh cruise planned to last three years, is progressing satisfactorily. Besides observations in terrestrial magnetism and atmospheric electricity, researches in physical oceanography, marine biology, radiotelegraphy and meteorology are being conducted. The vessel arrived at Plymouth, England, her first port of call, June 8, having been delayed by head-winds. Leaving Plymouth June 18, she reached Hamburg, Germany, June 22. She sailed from the latter port for Reykjavik, Iceland, July 7. A warm welcome was accorded the vessel and party both by English and German scientists. At Hamburg additional meteorological and oceanographic equipment was installed, and many constructive suggestions were made as the result of the recent *Meteor* expedition. Dr. H. U. Sverdrup, research associate of the Carnegie Institution of Washington, inspected the vessel and assisted in scientific installations at Hamburg.

On July 4, 1928, a monument was dedicated at Kenton, Oklahoma, marking the high point of the state. This monument, five feet in height, built of native basaltic lava and capped with an 18-inch cube of granite from the Wichita Mountains, is situated on Black Mesa near the northwest corner of the State of Oklahoma. Black Mesa is a table-land composed of volcanic rock which transgresses three miles into Oklahoma from New Mexico. The elevation as determined by surveyors of the topographic branch of the U. S. Geological Survey is 4,978 feet. Representatives were present at the dedication from the four states which corner near Black Mesa, namely, Kansas, Colorado, New Mexico and Texas. The dedication was in charge of Chas. N. Gould, state geologist of Oklahoma.

## UNIVERSITY AND EDUCATIONAL NOTES

The University of Chicago will receive a bequest of between $300,000 and $400,000 by the will of the late Adolph J. Lichstern, of Chicago.

A gift of $10,000 has been made by Mr. and Mrs. Charles P. Taft to the graduate school of arts and sciences in the University of Cincinnati.

It is announced that a resident in Chicago has offered £10,000 to Queens University, Ontario, Canada, to found a chair of preventive medicine and public health.

Professor J. H. Van Vleck, of the University of Minnesota, has accepted the professorship of theoretical physics at the University of Wisconsin and will begin his work there in September of the present year.

Professor Herbert Woodrow, head of the department of psychology at the University of Oklahoma, has been appointed professor and head of the department of psychology of the University of Illinois to succeed Professor Madison Bentley.

Dr. B. O. Koopman, of Columbia University, has been promoted to a full professorship of mathematics.

At Williams College, James B. Brissmade, assistant professor of physics, and Elbert C. Cole, assistant professor of biology, have been advanced to the rank of associate professor in their respective departments.

C. M. Suter, research associate at Yale University; R. K. Summerbell, of the Ohio State University; J. G. Aston, research assistant at Harvard University, and R. B. Reynolds, of the University of Wisconsin, have been appointed to the chemistry staff of Northwestern University.

Dr. John G. Sinclair, of the department of anatomy in the University of Wisconsin Medical School, has been appointed associate professor of embryology and histology at the University of Texas School of Medicine.

Professor E. N. da Costa Andrade, professor of physics at the Royal Military College, Woolwich, has been appointed by the University of London to the Quain chair of physics, tenable at University College.

## DISCUSSION AND CORRESPONDENCE

### THE PRODUCTION OF MUTATIONS BY X-RAYS IN HABROBRACON

MULLER[1] has shown that mutations, both lethal and visible, may be produced in *Drosophila melanogaster* by means of X-rays. Weinstein[2] has repeated and confirmed Muller's findings. Other investigators have by the same means subsequently induced germinal modifications in plants, of which some at least appear to be genic.

Early in 1927 similar tests were made at Muller's suggestion with the parasitic wasp, *Habrobracon juglandis* (Ashmead). No results were at first obtained, and it appeared that dosages adequate to sterilize the flies had little or no effect on the wasps. Further work with greatly increased dosages resulted in reduced fertility and at least one visible mutation (small head). There was also evidence of lethal mutations, but these were not checked by linkage, as was done in Drosophila.

After an interruption of some months, the work has been resumed with advantage of knowledge in regard to adequate dosage gained from the previous experiments. There have already resulted three visible mutations; one affecting the eyes, one the wings and one the body as a whole. The last is semilethal and linked with the locus for orange eye. Many lethals have apparently been produced as evidenced by decrease in (haploid) males, but no attempt has been made to follow out their method of inheritance. The heredity of the visibles is being traced.

It is significant that among the offspring of the relatively few treated wasps these mutations (including four visibles) have been found, while in previous work involving several hundreds of thousands of individuals not more than seven visibles have been detected.

Induction of sterility in Habrobracon shows some remarkable differences from what occurs in Drosophila. Experiments to test the meaning of these differences are now in progress.

P. W. WHITING

UNIVERSITY OF PITTSBURGH

### PLIOCENE URODELES IN WESTERN KANSAS

FOR the past four years, Mr. H. T. Martin, of the paleontological department of the University of Kansas, has been excavating and investigating a deposit of Lower Pliocene sand in Sherman County, Kansas. The work has been carried on in a cut where the drainage into the Smoky Hill River has made a gully about seventy-five feet deep in the surrounding prairie. The particular stratum worked is about twenty feet below the level of the prairie, and consists of a deposit of fine, silty sand in which a rich series of mammal remains are found, together with some skeletal fragments of birds, reptiles and amphibia, the latter occurring in large numbers.

When, in the course of the excavating, small bones were found in the sand, sieves were procured and used and about five tons of sand were carefully sifted to make more certain the collecting of this material. By this means the remains of over a hundred individuals of urodele amphibia were recovered. The skeletal material, although completely disarticulated, is perfectly preserved and completely fossilized and in such excellent condition that the bones can be studied and articulated as though they were fresh skeletal elements.

The condition of the bones shows that there has been no washing and little movement of any kind in the sands since they were deposited, for thin, paper-like bones such as parasphenoids are perfectly preserved.

A few natural articulations remain intact. Three stapes were recovered from the sand-filled cavity of the otic capsules, while in four specimens the stapes were ankylosed in position on the lips of the foramen ovale. Of one hundred and eighty angulars, the calcified articulars were in place in twenty-one specimens.

All parts of the axial and appendicular skeleton have been found and identified with the exception of small carpal and tarsal elements and some of the bones of the digits. All the elements of the skull were also obtained with the exception of the palatines and nasals, but since these are exceeding thin and delicate, only the merest chance would make their recovery possible and sieving would only serve to break them to pieces.

The deposits in which this amphibian material was found are typical of the early Pliocene. The age of these specimens must be judged from the animals associated with them in the sands; since, as pointed out above, it is apparently impossible that there could have been any washing or transposing of material, one is forced to the conclusion that the skeletons of the amphibia and the other animals were laid down in the sands at about the same time.

The following early Pliocene animals were found associated with these amphibia:—Aphelops, Pliohippus, Prosthenops, Procamelus, Pliauchenia, Dromo-

[1] Muller, H. J., "Artificial Transmutation of the Gene," SCIENCE, Vol. 66, pp. 84–87, 1927.

[2] Weinstein, Alexander, "The Production of Mutations and Rearrangements of Genes by X-rays," SCIENCE, Vol. 67, pp. 376–377, 1928.

meryx, Blastomeryx, Mylogaulus, Sciurus, Paomys, Aelurodon, Pseudaelurus, Machaerodus, together with a few bird, reptile and anuran bones.

A preliminary study of this urodele material shows that the specimens, numbering over a hundred individuals, belong to one species and must be placed in the family Ambystomidae and probably in the genus Ambystoma. The size of the skeleton would be about that of some of the larger members of the genus Ambystoma living to-day, averaging about 225 mm in length. A study of the material is now being carried on and a complete description and diagnosis will be available in the near future. In so far as the writers are aware, these are the first urodeles to be described from the Lower Pliocene.

L. A. Adams
H. T. Martin

University of Illinois
University of Kansas

## THE ALBINO RAT

The use of the term *Rattus norvegicus albinus* to designate the domesticated strain of albino rat, used so extensively in experimental laboratories, has been condemned by systematists on the grounds that albinos occur in practically all species and are only variants. That is a point for systematists to settle, but it seems evident that so far as the Wistar strain of white rats is concerned there is something more to be said. Recent work on the gametic composition of a colony of rats resulting from interbreeding the Wistar strain with the wild gray rat, *R. norvegicus* Erxl., a partial report of which appeared in the December 16, 1927, issue of Science, indicates the possibility of a greater difference between the parents than is ordinarily found in strains of one species.

The chromosomes of ninety rats have been examined, some of them being the ordinary albinos. No differences could be detected between the gametic composition of these and the other members of the group. A comparison of the albinos of the colony, however, and the Wistar strain of albinos, shows marked differences in gametic composition both in chromosome counts and in the chromosome number in the offspring resulting from matings made between them and other members of the colony. So far as our knowledge of the specificity of chromosome number and behavior goes at the present time, this would not be an expected result if the ordinary albinos of the colony and the Wistar strain were merely variants of one species. Examination of four wild gray rats, *Rattus norvegicus,* shows that these rats had a diploid count of forty-two chromosomes and both twenty-one and thirty-one chromosomes in the secondary spermatocytes, the dimorphism in the haploid number being the common characteristic of the members of our colony. According to Donaldson[1] the pure strain of albinos came from *R. norvegicus* and "is far removed from its wild ancestor and moderately inbred." How far this removal must be carried before species-differences arise is a matter of speculation, but the fundamental differences in gametic composition are suggestive in this connection. Since the ordinary albinos of the colony show the gametic composition of other members of the colony, it is probable that this change has occurred since the original strain of pure albinos was segregated from its wild ancestor.

This change is not confined to members of our own colony of mixed rats. The testes of two rats received from the laboratory of Professor R. A. Dutcher, Pennsylvania State College, gave chromosome counts of forty-two and sixty-two respectively, each showing both twenty-one and thirty-one chromosomes in the secondary spermatocytes. Members of a third colony came from Professor H. Steenbock, University of Wisconsin, in which the same conditions are found.

It seems possible that the primitive or basic number of chromosomes in *R. norvegicus* is forty-two, and that the dimorphism in the haploid number is a late acquisition, and that we have here a new species in the making which will ultimately come to have only 62–31 chromosomes.

Olive Swezy

Anatomical Laboratory,
University of California

## THE HIDING PLACES OF TREE-FROGS

A note in Science (Mar. 9, 1928) on "Tree-Frogs in Pitcher-Plants," by Dr. E. A. Andrews, of Johns Hopkins University, in which he calls attention to an association between pitcher-plants (*Sarracenia flava*) and the tree-frog (*Hyla cinerea*) observed near Beaufort, N. C., in June and July of 1888, brings to mind a similar observation made by us on June 21, 1924, in a region of the same type. While collecting near Washington, N. C., at the head of Pamlico Sound some sixty miles north of Beaufort, we came upon an extensive sphagnum swamp, at the time very dry and firm enough to walk about on, and found it filled with orchids and pitcher-plants, *Sarracenia flava* most abundant. The swamp is surrounded by thin pinewoods interspersed with scrub-oaks, these occurring also on the dry knolls in the sphagnum. While opening the pitcher-plants in order to collect the insects hidden in the deep greenish yellow funnels we were surprised to find a long, thin, green tree-frog.

[1] Donaldson, H. H., 1924, Wistar Institute, Philadelphia.

In the course of a half-hour's collecting we saw others but were unable to capture any of them. The funnels of these pitcher-plants were moist and cool in contrast to the surrounding dry and dusty woods and undoubtedly offered the most congenial conditions for these frogs.

In 1910 while collecting in Florida we found tree-frogs numerous in the moist troughs formed at the bases of the leaves of the common cabbage palmetto, especially where the surroundings were dry, as was the case near the sand-dunes on Anastasia island off Saint Augustine. The bases of the leaves of the common yucca (*Yucca aloifolia*) also harbor a population of insects and tree-frogs. In extreme southern Florida as well as on the tropical islands of the Caribbean sea it is usually possible to find tree-frogs in the moist centers of the numerous aroids growing on the trees and rocks. In Cuba, during the dry season, tree-frogs inhabit the moist and narrow space under the leaf-sheaths of the royal palms, even along dry and dusty highways.

Near the Harvard Biological Station at Soledad we surprised a small boa hunting out and eating the tree-frogs hidden in a roadside palm; in fact, it was the shrieks of a half-swallowed frog which disclosed the marauding boa. Along the streams near the Harvard Botanical Garden (Soledad) we collected tree-frogs in the same moist hiding-places as well as in the leaf-sheaths of the bananas. The cool damp places under the palm-sheaths, at the base of yucca leaves and palmetto leaves and inside the aroids harbor a great variety of insects, especially beetles, and sometimes earthworms and it has been while searching for insects that we have found the tree-frogs.

Beirne B. Brues

Forest Hills,
Boston

## CENTERS OF RESEARCH

The paucity and mediocrity of the research produced by some of the graduate schools of our large universities have been the subjects of a great deal of adverse censure. Out of this amazing amount of vituperation has come little or no constructive criticism.

That certain laboratories are making great contributions to science can not be disputed. Why, then, this great disparity between research laboratories? Leaving, for the time being, a discussion of personnel out of account, the author would venture the remark that a large part of the trouble is due to the matter of organization.

There seem to be two lines of development in this country. Either the department of research is under one outstanding leader or else the research students are divided between several members of the departmental staff.

European centers of research have, in general, adhered to the first method and their success has been attested by the number of American students who have flocked to work under certain great scholars. In this country we seem to have lost sight of this fact and as a result find too often the second plan of organization. If one sets down a list of research centers, classifying them under the two modes of organization just mentioned, I believe it will be a surprise to see how they align themselves.

It seems perfectly obvious that, in a department of research where students are working for a Ph.D. degree, the best results are to be obtained when they are all directed and supervised by one individual who has the *flair* for research.

A real *esprit de corps* can hardly be built up in a divided research group. It is the unity of the group which makes for success. The divided directorate of research suggests too much the chaos which has existed the past few years in China's government.

If an educational institution intends to set up a school of research in any department it will call one man as director of research for that department. The other teachers on the staff will be called to give certain courses and not to direct research. This would not mean that they should not do any research work. On the contrary, they would be encouraged to do it. If of sufficient ability such teachers should have assigned to them an assistant of Ph.D. caliber to help in their research work. So far as actual research work goes, a teacher with a good research assistant can get more done than he can directing six inexperienced Ph.D. candidates. It would be a great stimulus to the students in the department to see this sort of research work going on.

This plea for a centralized control of research is not calling for superhuman directors. It goes without saying that the best men available will be called to such an important position, but many laboratories would be turning out a much better product to-day if their research work were centralized in each department under one individual, even though the director were not a Nobel prize winner.

Our research laboratories would hum if each department could be directed by one leader of thought and action who had the enthusiasm for his subject which is contagious and to whom has been imparted that subtle gift of passing on to others the urge for creative scholarship.

S. R. Williams

Fayerweather Laboratory of Physics,
Amherst College

## MEASUREMENT OF RAPIDLY VARYING SURFACE TENSION

The determination of surface tension has acquired great importance in biological work and references to suitable methods have appeared on several occasions in Science. For the measurement of quickly changing surface tension, in addition to the ring method so ably championed by Dr. du Noüy, I have found very useful a simple form of the "pressure in bubble" method.[1] The "pressure in bubbles" method enables one to take readings within one fifth of a second or less after the formation of the surface and is of value especially when one deals with liquids giving elastic films, when the ring method can not be used.

Victor Cofman

E. I. du Pont de Nemours & Co.,
Wilmington, Delaware

## SCIENTIFIC APPARATUS AND LABORATORY METHODS

### A WEIGHT-DRIVEN KYMOGRAPH

When such phenomena as the speed of a nerve impulse or reaction time are to be recorded, a very fast kymograph drum is an absolute necessity. A weight-driven machine seems to serve the purpose more satisfactorily than one propelled by a spring.

Most instructors, who have tried to explain to the student in the laboratory of experimental physiology how to arrange the writing-points of the signal-magnet and of the muscle-lever in the same vertical line, open the switch, pluck the tuning fork and spin the drum a single revolution only, have been struck by the look of dismay upon the student's face. Such procedure requires good technic and plenty of patience. When the situation is complicated by a limited amount of time and a meager knowledge of technic, it is obvious that either simpler methods must be developed or these experiments must be omitted. Due to the great values being placed upon reaction times, it becomes advisable to devise simpler methods.

Therefore a stand was constructed for supporting the drum and the necessary devices for starting and stopping the drum, as well as a mechanism for producing break shocks. The stand consists of a triangular base of cast iron (Fig. 1), supported by three legs, as shown in Fig. 2. From one corner of the base arises a vertical pillar near whose point of origin is a slot to allow the placing of a pulley, such as a sash-pulley, over which the cord of the propelling weight passes. A horizontal limb arising from the vertical pillar is fitted with a 10/24 knurled head screw, 1-a, provided with a check nut. The end of this screw is sharply pointed to fit into the cupped end of the drum spindle, 1-d. This spindle is one-half inch in diameter to fit a Harvard drum, has cups at both ends and is of the proper length, about eleven and three quarter inches, to rest upon a steel point, 1-b, fitted into the base and to engage the screw, 1-a. Of course the base must be level and the spindle exactly in the vertical position.

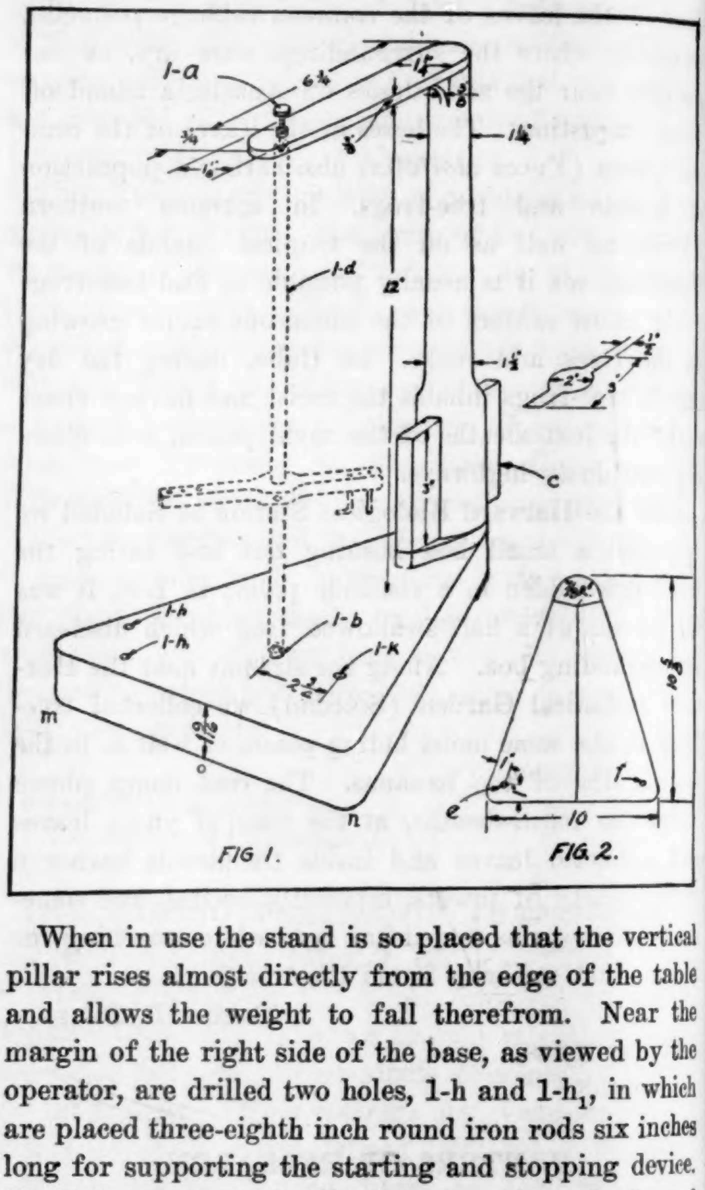


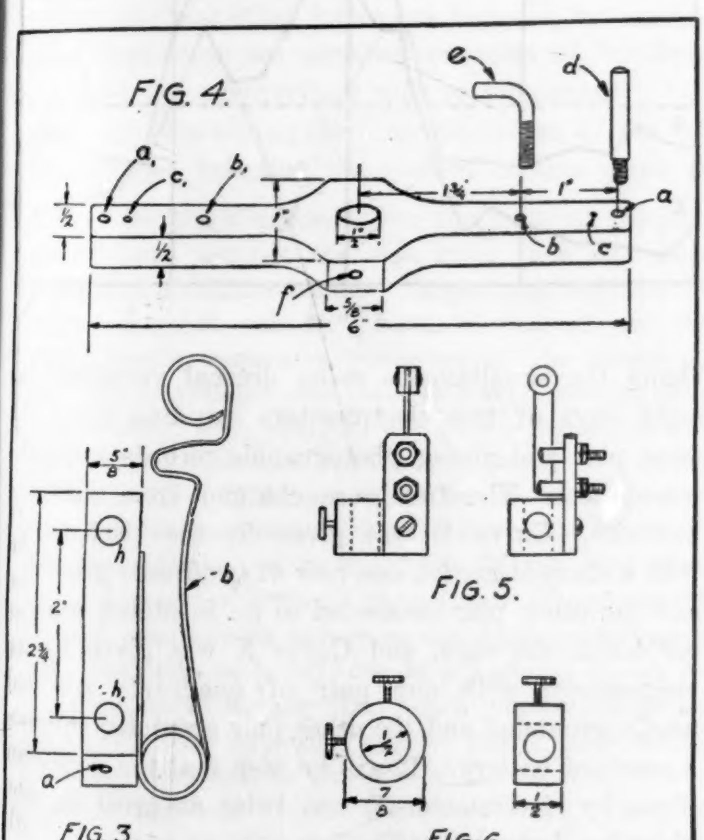
FIG 1. FIG. 2.

When in use the stand is so placed that the vertical pillar rises almost directly from the edge of the table and allows the weight to fall therefrom. Near the margin of the right side of the base, as viewed by the operator, are drilled two holes, 1-h and $1\text{-}h_1$, in which are placed three-eighth inch round iron rods six inches long for supporting the starting and stopping device. The latter is shown in Fig. 3 and consists of a bar of the dimensions shown in the figure, to the mesal surface of which is soldered a spring "latch" b, of the shape figured and made from number 26 piano-wire. Piano-wire is quite difficult to handle unless one end is firmly held in a vise. In construction the bar is first laid out and drilled, after which it is used as a guide for drilling the holes, 1-h and $1\text{-}h_1$, in the base of the stand.

A vertical brass rod, Fig. 4-d, projecting downward from the brass bar attached to the lower end of the drum, engages the U-shaped bend in the "latch" and serves as a means of holding the drum at rest and checking it at the proper time when in motion. This brass bar, whose dimensions are shown in Fig. 4, is

[1] *Chemical Reviews*, Vol. 4, p. 31.

bolted to the cross arm of a Harvard drum by means of two 4/36 round-head machine screws and is provided with the holes, a and $a_1$, for placing of the rod, d, holes b and $b_1$ for receiving an L-shaped "dog," e, which actuates the break-shock device, with holes c and $c_1$ for attaching the bar to the drum and finally with a one-half inch hole for the spindle. These holes are all drilled symmetrically so that the bars are interchangeable upon all drums used. An Allen set screw, f, serves to retain the bar on the spindle in the desired position. Much convenience results from the ability of changing the position of the "dogs," as it has been found best to place the lap of the drum paper opposite the "dogs," and the recording levers parallel with the side of the base opposite the pillar. The "dogs" d and e are made from round brass rod three-sixteenth inch in diameter. The brass bar, after removal of the dogs, may be allowed to remain upon the drum, thus facilitating a rapid shift from the weight-driven to spring-driven machines and *vice versa*. In Fig. 1 this brass bar is shown in proper position upon the spindle but without the drum.




The device for breaking the current is shown in Fig. 5. It consists of a single-pole double-throw radio-switch obtainable from five-and-ten-cent stores or from mail-order houses. One of the poles of the switch was removed, and a 4/36 round-head machine screw passed through the hole to attach the base of the switch to a brass block, which in turn is provided with a one-quarter inch hole for fitting it to the upright rod, 1-k, a round iron rod four inches long. If a Guthrie switch were used here it is probable that superimposed records of muscular contraction as well as records of simple contraction could be secured.

The braided or twisted cord about fifteen inches long extending from the propelling weight and over the pulley is attached to the spindle by means of a collar made from a short section of a seven-eighth inch round brass rod, Fig. 6, which has a hole of sufficient size to slip over the spindle. The collar is set upon the spindle by means of two knurled head 6–32 machine screws. The propelling weight used consists of a six inch-length of one and one-quarter inch steel-shafting which has become unsatisfactory for other purposes. Any other ten-pound weight would serve as well.

Construction of the stand: As the pattern differs but slightly from the finished stand and in details essential for construction only, the pattern has been shown in Fig. 1. The stand is cast on edge in order to make possible the placing of the foot beneath the pillar and the core, c, for the pulley-wheel slot. The dimensions of the base and of the pillar are given in Figs. 1 and 2. The thickness of the base should be as given at 0 in Fig. 1. In order to allow ready removal from the moulding sand, the edges M and N should be at least one-sixteenth inch less in thickness than at 0. This is accomplished by the removal of a few shavings from the bottom of the base with a plane.

The general process of manufacture consists in the cleaning of the casting after delivery from the foundry, drilling and tapping the holes for the two added feet made from one-half inch round iron rod, leveling the base and drilling the hole in the horizontal limb of the vertical pillar for the screw, 1-a, according to the dimensions given in Fig. 1. The stand is then placed upon a level bench and the point for the hole, 1-b, located by means of a plumb bob and a three-eighth inch hole drilled for the point to receive the lower end of the drum spindle. The hole, 1-k, is at a radius of two and one-quarter inches from the hole 1-b.

In operation, timed break-shocks may be delivered by wiring the primary of the inductorium in series with one or two dry-cells, the switch and the signal magnet.

SUMMARY

(1) Herein has been described a stand for supporting the drum, a device for starting and stopping the drum and a circuit-breaker for a weight-driven kymograph.

(2) This device has proved satisfactory for recording simple muscular contractions, for securing data for the determination of the speed of the nerve-impulse and for determining reaction times.

(3) With but a little training in technic, college freshmen have secured very good graphs with this apparatus.

(4) This machine, exclusive of the drum, has been constructed at less than one third the cost of a spring-driven kymograph, and the drum of the latter may readily be used for either, since but a few minutes are required to make the shift.

Alvah R. McLaughlin

Department of Physiology and Pharmacology,
Michigan State College

## SPECIAL ARTICLES

### A NEW ARRANGEMENT FOR SHOWING THE DIURNAL VARIATION IN THE INTENSITY OF THE EARTH'S-SURFACE CHARGE AT A GIVEN PLACE

During the past seven years I have been recording a diurnal variation in the deflection of a quadrant electrometer inside a grounded-wire cage with one pair of quadrants grounded to the cage and to the city water-system of Palo Alto, the other pair insulated and the needle charged. Set up in this way the electrometer has shown both a solar and a lunar diurnal variation in deflection which varies with the seasons, being much greater at the equinoxes than at the solstices, which is not due to temperature, illumination or atmospheric pressure and which is sometimes greatly disturbed by solar activity and by auroras.

I have attributed this variation to the inductive effect of the electric charges of the sun and moon upon the earth's charge; but this explanation has not met with general approval, partly, at least, because it is quite commonly held that it is impossible that the sun as a whole can be highly electrified, though the tremendous charges in sun-spot regions are quite generally accepted.

One of the most plausible explanations of the phenomenon which have been offered, and the one which is most often proposed, is that it is due in some way to a diurnal variation in the electrical conductivity of the air. This has seemed the more plausible because a number of observers have recorded similar electrometer deflections which they have attributed to changes in atmospheric conductivity, due to penetrating radiations or other causes.

I have several times offered what seem to me to be conclusive objections to this interpretation of my observations, and I wish now to give a definite experimental proof that the phenomenon is not due to variations in atmospheric conductivity.

If a quadrant electrometer have one pair of quadrants and the needle grounded to the inside of a hollow conductor which is also grounded and have the other pair of quadrants connected to one pole of a constant battery, the other pole of which is also grounded to the inside of the hollow conductor, we have an arrangement in which the electrometer will not be disturbed by any changes in the conductivity of the air. The needle and one pair of quadrants must necessarily remain at the same electrical potential as the earth, and the charged quadrants must remain at a constant potential difference from the needle and the grounded pair.

An electrometer set up in this way shows the same diurnal variation in deflection as does the one which I have been using for the past seven years. Fig. 1

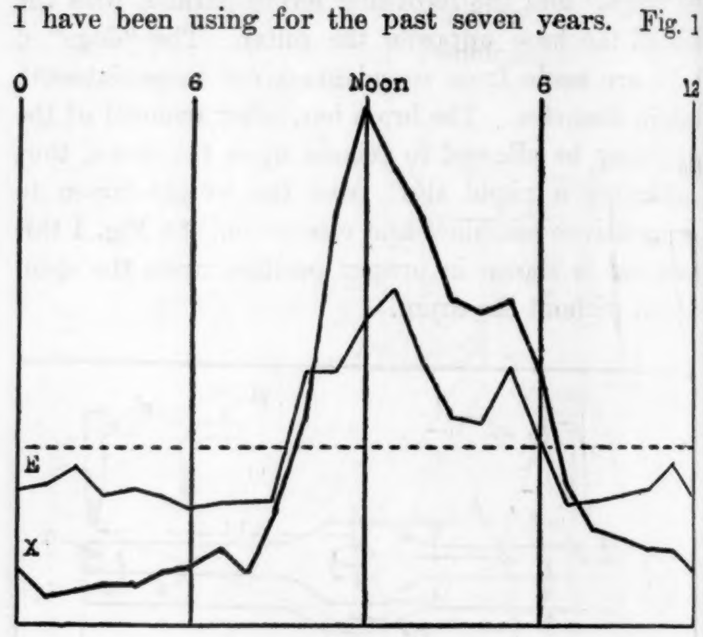



Fig. 1

shows the simultaneous mean diurnal variation for eight days of two electrometers standing upon the same pier and giving photographic records upon the same sheet. The two were charged from different batteries. Curve E was given by the electrometer with a charged needle, one pair of quadrants grounded and the other pair connected to an insulated conductor inside the cage, and Curve X was given by an electrometer with one pair of quadrants and the needle grounded and the other pair grounded through a constant battery. It will be seen that the deflection given by electrometer X was twice as great as that given by electrometer E.

The fact that the electrometer deflections have both a solar and a lunar diurnal period as well as a seasonal period shows that they are dependent upon the sun and moon, and their electrostatic nature will hardly be questioned. Also, the fact that the solar variation is several times as great as the lunar shows that they are not due to gravitational tides.

Since most of my previous statements in regard to this phenomenon have been declared impossible by *a priori* physicists, I have no doubt that this one will

share the same fate, but every physics laboratory has facilities for testing it.[1]

FERNANDO SANFORD

PALO ALTO,
CALIFORNIA

## THE BACTERIAL LIGHT ORGAN OF CERATIAS

PIERANTONI[1] and Zirpolo[2] were the first to describe living bacteria as the normal source of light in the luminous organ of an organism, *Sepiola*, a squid. Basing their opinion on this, they have attempted to show that such bacteria are the source of light, not only in this squid, where the bacteria are found in the open lumen of the gland, but also in many other luminous organs where the objects supposed to be bacteria are those hitherto identified as secreted granules of luciferin that operate *in situ* in the cells that formed them or in the lumen of the gland or after being ejected from the gland.

While the writer agrees that the bacterial origin of the light has been fairly well proven in the case of *Sepiola*, he does not agree with the idea that the light granules in these other forms are bacteria, but is convinced that they are secreted granules of luciferin formed by the specific light cells of the organ.

Harvey[3] in studying the luminous organ of the fish *Katablephron* describes the content of this gland as a mass of luminous bacteria and although he was unable to cultivate them the case seems to be pretty well established. Y. Yasaki[4] has made a more detailed study of the light organ on the tip of the lower jaw of the fish *Monocentris japonicus* and has proved more definitely that the light is produced by living bacteria harbored by this gland. Recently, Harms[5] has described the remarkable case of an East Indian fish *Equula*, which has developed a light organ from the epithelium of the esophagus. Here again the light seems to take its origin from bacteria that live in masses in the lumen of the gland. Full weight is given to this discovery by Harms' ability to demonstrate the bacteria as constituting the major bulk of the content of the gland.

The writer has been studying the open gland found on the tip of the anterior dorsal fin ray of a species of *Ceratias*, and again it seems certain that the light from this organ is produced by bacteria which fill a large portion of its lumen. Owing to the rarity of this fish and the difficulties under which it must always be secured (it is a deep sea form captured dead by the dredge or tow net) it has been impossible to study the organ in any natural condition. But the bacteria have been seen and its agreement in structure with the bacterial light organs of the other four forms seems to identify its function with theirs.

This organ on the fin ray of *Ceratias* is evidently an ectodermal invagination whose fundus consists of several thousand acini arranged in the form of a hollow sphere and discharging inward through their ducts into a central chamber. From this chamber the contents of the gland pass distally through an aperture in the spherical line of glands into a second and more distal chamber and from this latter again into a third chamber from which a small duct leads to the exterior. A second small duct also leads out from the second chamber and opens to the exterior, close to the other duct, on the distal and anterior surface of the total organ.

The entire organ, as has been described by Brauer, is quite globular in shape and is invested, as is the rest of the body, with a deeply black, pigmented layer which would shut in all light produced internally except near the distal extremity where a circular zone is wanting in pigment altogether. In life this "illuminating zone" must be quite transparent and the only surface of the organ from which light rays could emerge.

[1] Since the above article was in the hands of the publishers I have modified the experiment in a still more striking and conclusive manner. A quadrant electrometer has one diagonal pair of quadrants removed and the metallic needle suspension connected to the remaining pair. The instrument thus becomes a very sensitive electroscope which, when charged, will give a rotation of the needle. The system thus formed is insulated upon amber supports inside a brass case which is inside of and connected with an earthed wire cage. Set up in this way, after being discharged to the inside of the wire cage, with no battery or artificial charge near it, and doubly protected from outside induction, the needle undergoes a double deflection each day, due to a negative charge on the instrument in the day time and a positive charge on it at night. The deflections are not due to temperature, barometric variations or changes in illumination. Their magnitude has been greater than is caused by charging the instrument to 150 volts. They seem to be due to a positive charge on the day side of the earth and a negative charge on the night side, which charges can not be shared with the insulated instrument.

[1] Pierantoni, U., "Gli organi simbiotici e la luminescenza batterica dei Cefalopode," Pub. Staz. Zool., Napoli, Vol. 20, p. 105, Tav. 6–8, 1917.

[2] Zirpolo, G., "I batteri Fotogeni degli organi luminose de *Sepiola intermedia* Naef.," 1918.

[3] Harvey, E. N., "The Production of Light by the Fishes *Photoblephron* and *Anomalops*," Pub. No. 313, Carnegie Inst. of Washington, pp. 43–60.

[4] Yasaki, Y., "On the Nature of the Luminescence of the Knightfish, *Monocentris japonicus* (Houttum)," *Journ. of Exper. Zool.*, Vol. 50, No. 3, April, 1928.

[5] Harms, J. W., "Bau und Entwicklung eines Eigenartigen Leuchtorgans bei *Equula spec.*," *Zeit. f. Wiss. Zool.*, Vol. 131, first part, 1928.

Thus we have a third kind of fish and a fourth organism in which this interesting method of light production is evident, but important work remains to be done on one or more of them. The kinds of bacteria used, the nature of the gland secretion and its effects on the bacteria, whether the organ was originally auto-luminous and the possibility that the secretion is still a luciferin or not and many other interesting questions remain to be solved. The writer has more extensive studies on this organ in progress.

ULRIC DAHLGREN

## THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

### THE SOUTHWESTERN DIVISION

THE ninth annual meeting of the Southwestern Division of the American Association for the Advancement of Science was held at Flagstaff, Arizona, from April 23 to 26, inclusive. The meeting opened with a general session in the auditorium of the Northern Arizona Teachers College. As both the president and vice-president of the division were unavoidably absent, Dr. O. C. Lester, a member of the executive committee, was selected as acting chairman for the meeting. American Forest Week was properly observed by a program presented at the first noon-day symposium, at which time short interesting and instructive talks were made by Mr. F. C. W. Pooler, district forester of the Southwestern District of the United States Forest Service, and by two other members of the Forest Service, Mr. Quincy Randles and Mr. Herman Krauch. A general dinner on Monday evening was followed by a lecture on the Boyce Thompson Southwestern Arboretum by the director, Mr. F. J. Crider. The talk was illustrated with three reels of motion pictures, showing the vegetation in the vicinity of the arboretum and the work being carried on there. Tuesday evening a picnic supper near Sunset Peak, an old volcanic crater, was followed by an open house at the Lowell Observatory. Here the members had an opportunity of viewing the moon through the large telescope and to examine many celestial photographs. On Wednesday noon at a luncheon symposium the future of the Southwestern Division and ways and means of securing new members were discussed. Wednesday evening, Mr. E. C. La Rue, who was for many years with the U. S. Geological Survey, studying the Colorado River, gave an illustrated talk on "The Colorado River and the Possible Damsites."

On Thursday, an excursion to Tuba City under the leadership of Dr. H. S. Colton was enjoyed by many members of the division. The features of the excursion were the various geological formations, dinosaur tracks, the Painted Desert, the Moencopi Pueblo, ancient Indian ruins and a wide variety of vegetation.

The biological sciences section program had twenty-nine titles listed. Wednesday afternoon the members of the section visited the Southwestern Forest Experiment Station near Flagstaff, where the silvicultural and grazing research work underway was shown and explained by members of the staff. One session each was devoted to plant pathology and forestry, and two to general biological papers. The physical sciences section had an exceptionally strong program, with forty titles listed. The discussion of Meteor Crater by Mr. G. M. Colvocoresses excited considerable interest and many members of the section visited the crater Tuesday afternoon. One session each was devoted to geology, physics, chemistry and astronomy. The social science section had sixteen titles listed. Members of this section were able to study many ruins easily accessible to Flagstaff. The education section had a rather short program, but the papers presented made up in quality what was lacking in quantity.

Newly elected officers of the Southwestern Division are: Forrest Shreve, Carnegie Desert Laboratory, Tucson, *president*; Walter P. Taylor, U. S. Biological Survey, Tucson, *vice-president*; W. G. McGinnies, University of Arizona, Tucson, *secretary-treasurer*, and Francis Ramaley, University of Colorado, Boulder, *member of executive committee.*

Section officers for the coming year are: Biological Sciences, F. J. Crider, director, Boyce Thompson Southwestern Arboretum, Superior, Arizona, *chairman,* Quincy Randles, U. S. Forest Service, Albuquerque, New Mexico, *vice-chairman,* W. G. McGinnies, University of Arizona, *secretary*; Physical Sciences, T. F. Buehrer, University of Arizona, *chairman,* R. J. Leonard, University of Arizona, *vice-chairman,* R. S. Rockwood, University of New Mexico, *secretary*; Social Sciences, K. M. Chapman, School of American Research, Santa Fé, *chairman,* Mrs. Eileen E. Alves, El Paso, *vice-chairman,* O. S. Halseth, Arizona Museum, Phoenix, *secretary*; Education, Grady Gammage, Northern Arizona Teachers College, Flagstaff, *chairman,* Samuel Burkhard, Tempe Normal School, Tempe, *secretary.*

The local committee, under the leadership of Dr. Grady Gammage, was largely responsible for making this meeting an outstanding success. The program was an unusually full one, and the entertainment and attractions afforded will make this meeting one long to be remembered by all who attended.

The tenth annual meeting of the division will be held in Albuquerque, April 22 to 25, 1929.

W. G. MCGINNIES,
*Secretary*